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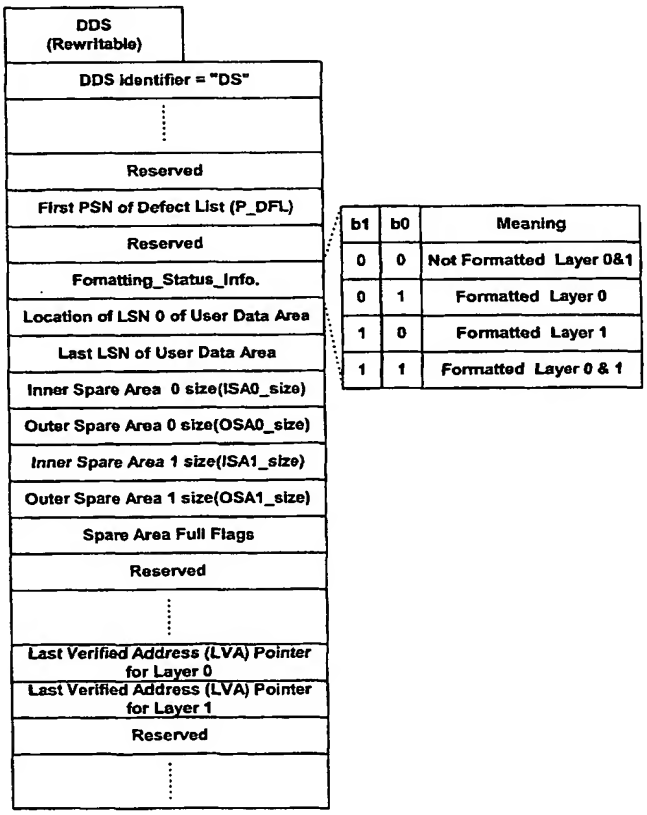
[Continued on next page]

(54) Title: HIGH-DENSITY MULTI-LAYER OPTICAL DISC AND METHOD FOR MANAGING LAYER FORMATTING THEREOF



(57) Abstract: A high-density multi-layer optical disc and a method for managing layer formatting thereof. A high-density multi-layer optical disc such as a Blu-ray disc rewritable (BD-RE) dual layer includes management information, additionally recorded in a lead-in area, needed for identifying formatting status of a plurality of recording layers. After the management information is referred to, at least one unformatted recording layer is automatically formatted. Optionally, the unformatted recording layer is formatted on the basis of a formatting method selected by a user. The multiple recording layers formed on the high-density multi-layer optical disc can be conveniently and effectively formatted.

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DESCRIPTION

HIGH-DENSITY MULTI-LAYER OPTICAL DISC AND METHOD FOR MANAGING LAYER FORMATTING THEREOF

1. Technical Field

The present invention relates to a high-density multi-layer optical disc on which multiple layers are formed and a method for managing layer formatting thereof.

2. Background Art

As standardization of a high-density rewritable optical disc, e.g., a Blu-ray disc rewritable (BD-RE), capable of storing high-quality video and audio is rapidly progressed, it is expected that related products will be developed, commercialized and supplied.

A conventional BD-RE single layer 100 is shown in Fig. 1. As shown in Fig. 1, there is a distance of approximately 0.1 mm between a recording layer and the surface of a transparent film being arranged between the recording layer and an objective lens (OL) 11 of an optical pick-up.

When an optical disc apparatus for reading and reproducing data recorded on the recording layer of the BD-RE single layer 100 or recording data thereon determines that a defect is detected on the layer 100 while performing a data recording operation, the optical disc apparatus records the data in an inner spare area (ISA) or outer spare area (OSA) separately assigned to a data area as shown in Fig. 2, in place of a data area.

Further, the optical disc apparatus generates a defect list (DFL) entry needed for identifying a cluster associated with a recording unit block (RUB) recorded in the spare area in place

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of a data area, and performs a recording and management operation for the generated DFL entry.

As shown in Fig. 2, management information associated with the spare areas and defects is contained and recorded in a field of rewritable disc definition structure (DDS) information of a lead-in area. The DDS information includes information items associated with the first physical sector number (PSN) of the DFL (P_DFL), a location of a logical sector number (LSN) 0 of a user data area, the last LSN of the user data area, a size of the ISA (ISA_size), a size of the OSA (OSA_size), spare area full flags indicating whether or not the respective spare areas are full, etc.

As described above, when the defect is detected in the data area while the optical disc apparatus records data in the data area, the optical disc apparatus searches for the spare area full flags contained and recorded in the DDS information field, selects the ISA or OSA in which the data can be recorded, and performs a sequence of data recording operations for recording the data in the selected spare area.

The recording layer of the BD-RE single layer 100 must be previously formatted so that the data can be recorded on the recording layer. The layer formatting method includes a general formatting method requiring a long formatting time, a recently proposed background formatting method, etc. Here, the background formatting method is that a formatting operation is performed automatically when or whenever the recording or reproducing device is idle, and stores information associated with the location of a formatted area until a time point when a data recording request is received from a user, thereby enabling the data, corresponding to the data recording request, to be recorded in the formatted area until the time point.

A high-density multi-layer optical disc, i.e., a BD-RE dual layer, capable of recording twice as much video and audio data

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as the BD-RE single layer, has been developed. As shown in Fig. 3, there is a distance d2 between the first recording layer (Layer 0) and the second recording layer (Layer 1) formed in the BD-RE dual layer 200. The first and second recording layers are formed at a location, within the BD-RE dual layer 200, having a bias toward the OL 11 of the optical pick-up.

The ISA and OSA are separately assigned to each of data areas associated with the first and second recording layers of the BD-RE dual layer 200. The first and second recording layers can be linked to each other so that large-capacity data can be recorded. However, there is not yet provided a method for effectively formatting the first and second recording layers provided in the BD-RE dual layer 200.

3. Disclosure of Invention

Therefore, it is one object of the present invention to provide a high-density multi-layer optical disc such as a Blu-ray disc rewritable (BD-RE) dual layer and a method for managing layer formatting thereof, which can record and manage management information needed for identifying formatting status associated with multiple recording layers formed on the disc and automatically perform a formatting operation of an unformatted recording layer, or perform the formatting operation in response to a user's selection.

In accordance with one aspect of the present invention, the above and other objects can be accomplished by the provision of a high-density multi-layer optical disc, comprising: a plurality of recording layers formed thereon; and management information, additionally recorded in a specified area thereof, needed for identifying formatting status of the recording layers.

In accordance with another aspect of the present invention, there is provided a method for managing layer formatting of a high-density multi-layer optical disc, comprising the steps of: (a) reading management information indicating formatting status

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of recording layers, while the management information being recorded in a specified area of the high-density multi-layer optical disc; (b) determining formatting status of recording layers based on the read management information; and (c) performing a formatting operation automatically or in response to a user's selection for at least one unformatted recording layer according to a result of the determination..

4. Brief Description of Drawings

The accompanying drawings, which are included to provide a further understanding of the invention, illustrate the preferred embodiments of the invention, and together with the description, serve to explain the principles of the present invention.

Fig. 1 is a view illustrating the structure of a conventional Blu-ray disc rewritable (BD-RE);

Fig. 2 is a table illustrating disc definition structure (DDS) information recorded and managed in a lead-in area of the conventional BD-RE;

Fig. 3 is a view illustrating the structure of a high-density dual-layer optical disc;

Fig. 4 is a view illustrating a state where disc definition structure (DDS) information is contained in a lead-in area of the high-density dual-layer optical disc in accordance with the present invention;

Fig. 5 is a table illustrating the DDS information recorded and managed in the lead-in area of the high-density dual-layer optical disc in accordance with the present invention;

Fig. 6 is a view illustrating the configuration of an optical disc apparatus to which a method for managing layer formatting of a high-density multi-layer optical disc is applied in accordance with the present invention;

Figs. 7A and 7B are flowcharts illustrating the method for managing layer formatting of a high-density multi-layer optical disc in accordance with the present invention; and

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Fig. 8 is a view illustrating an image of an on-screen display (OSD) displayed by the method for managing layer formatting of a high-density multi-layer optical disc in accordance with the present invention.

Features, elements, and aspects of the invention that are referenced by the same numerals in different figures represent the same, equivalent, or similar features, elements, or aspects in accordance with one or more embodiments.

5. Modes for Carrying out the Invention

A high-density multi-layer optical disc and a method for managing layer formatting thereof in accordance with preferred embodiments of the present invention will be described in detail with reference to the annexed drawings.

Fig. 4 is a view illustrating a state where disc definition structure (DDS) information is contained in a lead-in area of a high-density dual-layer optical disc in accordance with the present invention.

As shown in Fig. 4, the lead-in area is assigned to the first recording layer (Layer 0) and a lead-out area is assigned to the second recording layer (Layer 1) in a high-density multi-layer optical disc, e.g., a Blu-ray disc rewritable (BD-RE) dual layer 200, in accordance with the present invention. The first inner spare area (ISA) (ISA0) and first outer spare area (OSA0) 1 are separately assigned to a data area for the first recording layer. The second ISA (ISA1) and second OSA (OSA1) are separately assigned to a data area for the second recording layer.

Management information needed for managing a plurality of spare areas separately assigned to the data area for each recording layer and defect management address (DMA) information needed for managing a defect are rewritable disc definition structure (DDS) information. The rewritable DDS information can be recorded and managed in the lead-in area of the first recording layer. The DDS information can include formatting status

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information needed for identifying the formatting status of the first and second recording layers. Also, the DDS information can include the last verified address (LVA) pointer for each layer. The LVA pointer can specify the first physical sector number (PSN) for the last cluster that has been formatted by a formatting operation. This pointers are only valid when the disc has been partially formatted and when a formatting operation is in progress.

Fig. 5 is a table illustrating the DDS information recorded and managed in the lead-in area of the high-density dual-layer optical disc in accordance with the present invention.

As shown in Fig. 5, the DDS information includes information items associated with the first physical sector number (PSN) of a defect list (DFL) (P_DFL), a location of a logical sector number (LSN) 0 of a user data area, the last LSN of the user data area, a size of the first ISA (ISA0_size) for the first recording layer, a size of the second ISA (ISA1_size) for the second recording layer, a size of the first OSA (OSA0_size) for the first recording layer, a size of the second OSA (OSA1_size) for the second recording layer, spare area full flags indicating whether or not the respective spare areas are full, the formatting status information (Formatting_Status_Info.) having the predetermined number of bits, last verified address (LVA) pointer for the first recording layer, and last verified address (LVA) pointer for the second recording layer.

For example, where Formatting_Status_Info. = "00", the 2-bit formatting status information indicates the status in which the first and second recording layers are not formatted. Where Formatting_Status_Info. = "01", the 2-bit formatting status information indicates the status in which only the first recording layer is formatted. Where Formatting_Status_Info. = "10", the 2-bit formatting status information indicates the status in which only the second recording layer is formatted. Where

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Formatting_Status_Info. = "11", the 2-bit formatting status information indicates the status in which the first and second recording layers are formatted.

A recording layer indicated as unformatted by Formatting_Status_Info. can be a partially formatted layer. And if a recording layer has been partially formatted, the first physical sector number (PSN) of the last cluster that has been formatted can be written in the last verified address (LVA) pointer for the recording layer. So a formatting operation for a partially formatted recording layer could be continued from the PSN of the LVA pointer for the partially formatted recording layer.

The optical disc apparatus searches for and confirms the formatting status information. The optical disc apparatus determines whether the respective recording layers of the BD-RE dual layer 200 loaded in the apparatus are formatted to record the data. According to a result of the determination, the optical disc apparatus automatically formats an unformatted recording layer using a predetermined formatting method, e.g., a background formatting method, or performs a series of formatting operations using a formatting method selected or designated by the user. The above-described procedure will be described in detail.

Fig. 6 is a view illustrating a configuration of the optical disc apparatus to which the method for managing layer formatting of a high-density multi-layer optical disc is applied in accordance with the present invention. For example, an optical disc apparatus such as a video disc recorder (VDR) for recording or reproducing data of a BD-RE dual layer includes an optical pick-up 50 for reading data recorded on a high-density multi-layer optical disc 200 such as the BD-RE dual layer or recording a data stream corresponding to a processed signal; a VDR system 51 for performing a signal processing operation so that a signal of the data read by the optical pick-up 50 can be

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reproduced or converting an externally inputted data stream into a data stream appropriate for recording; and an encoder 52 for encoding an externally inputted analog signal and outputting the encoded analog signal to the VDR system 51.

Figs. 7A and 7B are flowcharts illustrating the method for managing layer formatting of a high-density multi-layer optical disc in accordance with the present invention.

As shown in Figs. 7A and 7B, where the high-density multi-layer optical disc, e.g., the BD-RE dual layer 200, is inserted and loaded in the VDR system 51 of the optical disc apparatus, a sequence of optical disc loading operations is performed and a lead-in area of the optical disc is accessed at step S10.

Then, the VDR system 51 reads disc information (DI) and disc definition structure (DDS) information recorded in the lead-in area and then stores the read information in an internal memory (not shown) provided in the optical disc apparatus at step S11. At this time, the DDS information containing formatting status information is stored in the memory at the above step S11.

Then, the VDR system 51 confirms the formatting status information at step S12. Where the formatting status information (Formatting_Status_Info.) = "00", the VDR system 51 determines that the first and second recording layers of the BD-RE dual layer 200 are not formatted at step S14.

For example, an image of an on-screen display (OSD) containing a message indicating that the first and second recording layers are not formatted, a selection menu for allowing the user to select the first recording layer and/or the second recording layer to be formatted, etc., is displayed through the screen of a television coupled to the optical disc apparatus at step S15.

The VDR system 51 performs a formatting operation for the first recording layer and/or the second recording layer selected

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by the user at step S16. At this time, the formatting operation is based on a general formatting method or a background formatting method.

Then, the VDR system 51 can appropriately perform a data recording operation for recording data on the formatted first recording layer and/or second recording layer in response to the user's request at step S17.

On the other hand, where the formatting status information (Formatting_Status_Info.) = "01" at step S20, the VDR system 51 determines that only the first recording layer of the BD-RE dual layer 200 is formatted at step S21.

Then, the VDR system 51 automatically performs the formatting operation for the unformatted second recording layer using the predetermined background formatting method at step S23.

Then, the VDR system 51 can appropriately perform the data recording operation for recording the data on the formatted first or second recording layer in response to the user's request at the above step S17.

On the other hand, where the formatting status information (Formatting_Status_Info.) = "10" at step S30, the VDR system 51 determines that only the second recording layer of the BD-RE dual layer 200 is formatted at step S31. Then, the VDR system 51 automatically performs the formatting operation for the unformatted first recording layer using the predetermined background formatting method at step S32. Then, the VDR system 51 appropriately performs the data recording operation for recording the data on the formatted first or second recording in response to the user's request layer at step S33.

On the other hand, where the formatting status information (Formatting_Status_Info.) = "11", the VDR system 51 determines that the first and second recording layers of the BD-RE dual layer 200 are formatted at step S40. Then, the VDR system 51 can perform the data recording operation in response to the user's request

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without additionally performing the formatting operation at the above step S33.

Meanwhile, a partially formatted recoding layer indicated as unformatted by the Formatting_Status_Info. can be formatted from the PSN of the LVA pointer for the partially formatted recording layer. The formatting operation for the partially formatted recording layers can be continued from the PSN of the LVA pointer for the partially formatted recording layers at the above steps S16, S23, and S32.

As apparent from the above description, the present invention provides a high-density multi-layer optical disc and a method for managing layer formatting thereof, which can conveniently and effectively format multiple recording layers formed on the high-density multi-layer optical disc.

The preferred embodiments of the present invention have been disclosed for illustrative purposes. Those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

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CLAIMS

1. A high-density multi-layer optical disc, comprising:

a plurality of recording layers formed thereon; and

management information, additionally recorded in a specified area thereof, needed for identifying formatting status of the recording layers.

2. The high-density multi-layer optical disc as set forth in claim 1, wherein the management information is recorded in disc definition structure (DDS) information contained in the lead-in area.

3. The high-density multi-layer optical disc as set forth in claim 2, wherein the management information consists of the predetermined number of bits indicating the formatting status of the recording layers.

4. The high-density multi-layer optical disc as set forth in claim 2, wherein the management information comprises the status information indicating that none of first and second recording layers are formatted, or only the first or second recording layer is formatted, or all of the first and second recording layers are formatted, if the high-density multi-layer optical disc is a dual-layer optical disc.

5. The high-density multi-layer optical disc as set forth in claim 1, further comprises position information for respective recording layers, while the position information specifying a first physical sector number (PSN) of the last unit that has been formatted.

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6. A method for managing layer formatting of a high-density multi-layer optical disc, comprising the steps of:

(a) reading management information indicating formatting status of recording layers, while the management information being recorded in a specified area of the high-density multi-layer optical disc;

(b) determining formatting status of recording layers based on the read management information; and

(c) performing a formatting operation automatically or in response to a user's selection for at least one unformatted recording layer according to a result of the determination.

7. The method as set forth in claim 6, wherein the step (a) comprises the steps of:

(a-1) searching for disc definition structure (DDS) information contained in the lead-in area;

(a-2) reading the management information having the predetermined number of bits recorded in the DDS information; and

8. The method as set forth in claim 6, wherein the step (c) is carried out by automatically performing a formatting operation for said at least one unformatted recording layer using a predetermined formatting method, if said at least one unformatted recording layer exists as the result of the determination.

9. The method as set forth in claim 8, wherein the predetermined formatting method is a background formatting method.

10. The method as set forth in claim 6, wherein the step (c) is carried out by generating and outputting an image of an on-screen display (OSD) indicating that all recording layers are

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not formatted if none of the recording layers are formatted as the result of the determination, and performing the formatting operation in response to the user's selection.

11. The method as set forth in claim 10, wherein the OSD image comprises a selection menu for allowing the user to select said at least one unformatted recording layer to be formatted and a formatting method.

12. The method as set forth in claim 6, wherein the step (a) further comprises the step of reading position information for respective recording layers, while the position information specifying a first physical sector number of the last unit that has been formatted.

13. The method as set forth in claim 12, wherein the step (c) is carried out by continuing a formatting operation for said at least one unformatted recording layer from the PSN contained in the read position information.

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FIG. 1

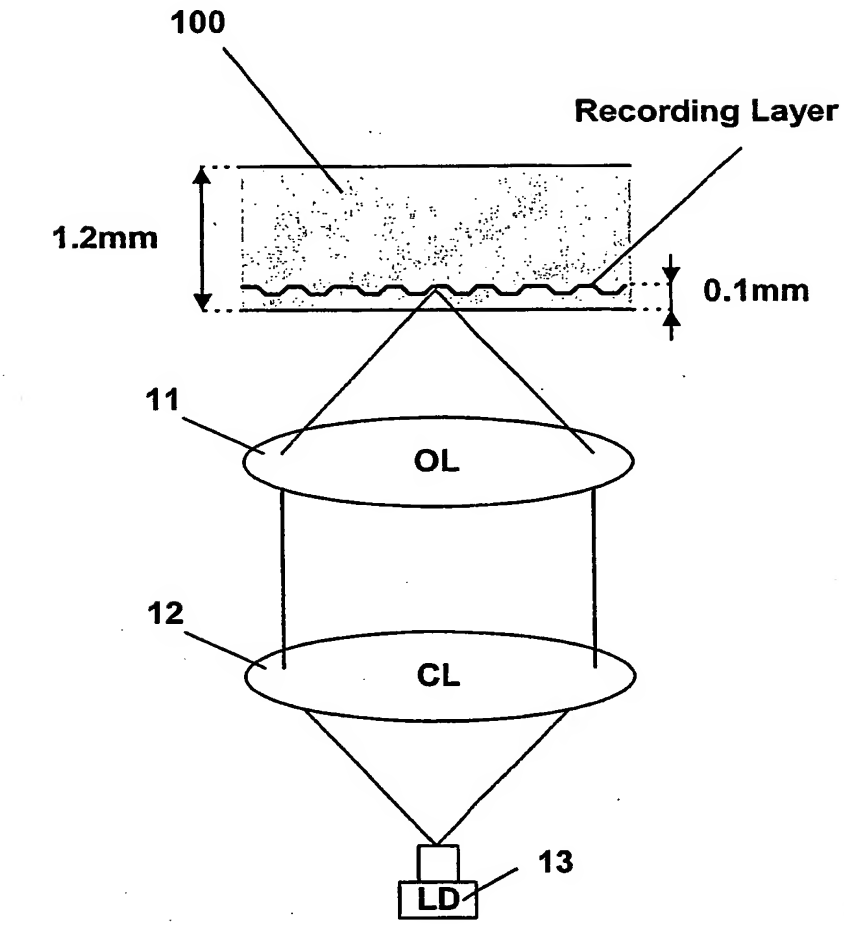

BD-RW Single Layer (100)
100
Recording Layer
1.2mm
0.1mm
11
OL
12
CL
13
LD

FIG. 2

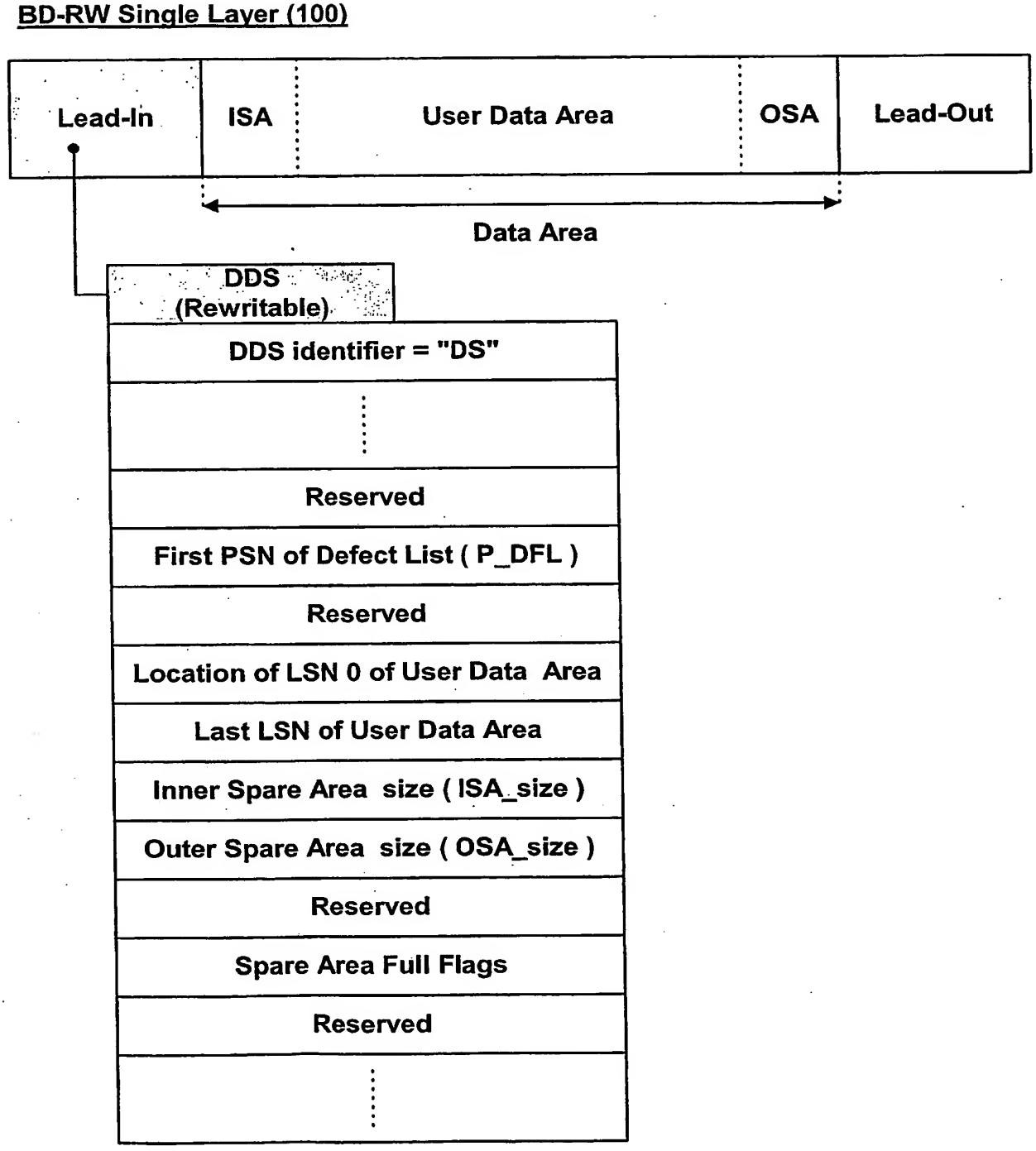

BD-RW Single Layer (100)
Lead-In
ISA
User Data Area
OSA
Lead-Out
Data Area
DDS (Rewritable)
DDS identifier = "DS"
Reserved
First PSN of Defect List (P_DFL)
Reserved
Location of LSN 0 of User Data Area
Last LSN of User Data Area
Inner Spare Area size (ISA_size)
Outer Spare Area size (OSA_size)
Reserved
Spare Area Full Flags
Reserved

FIG. 3

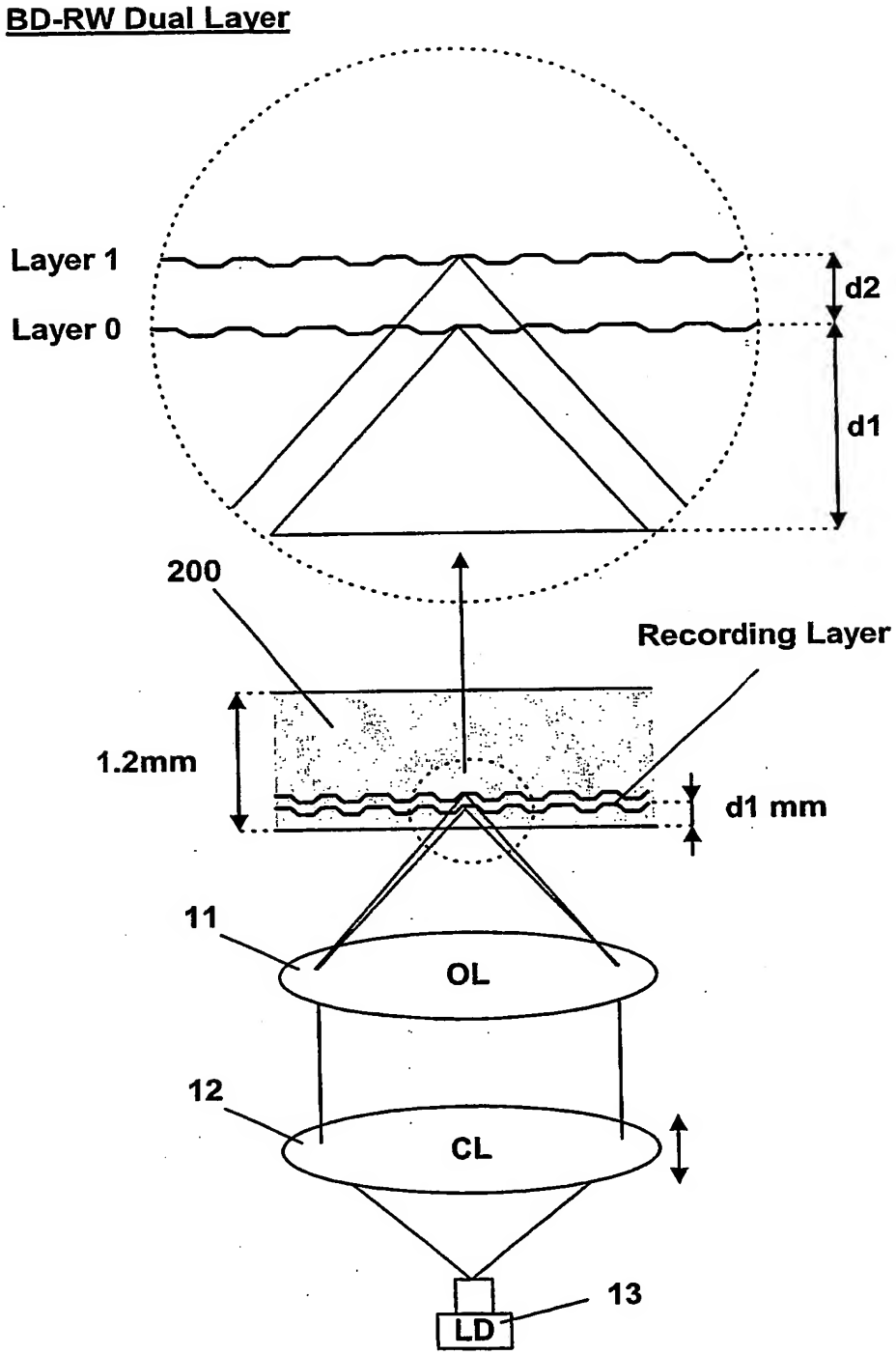

BD-RW Dual Layer
Layer 1
Layer 0
d2
d1
200
Recording Layer
1.2mm
d1 mm
11
OL
12
CL
13
LD

FIG. 4

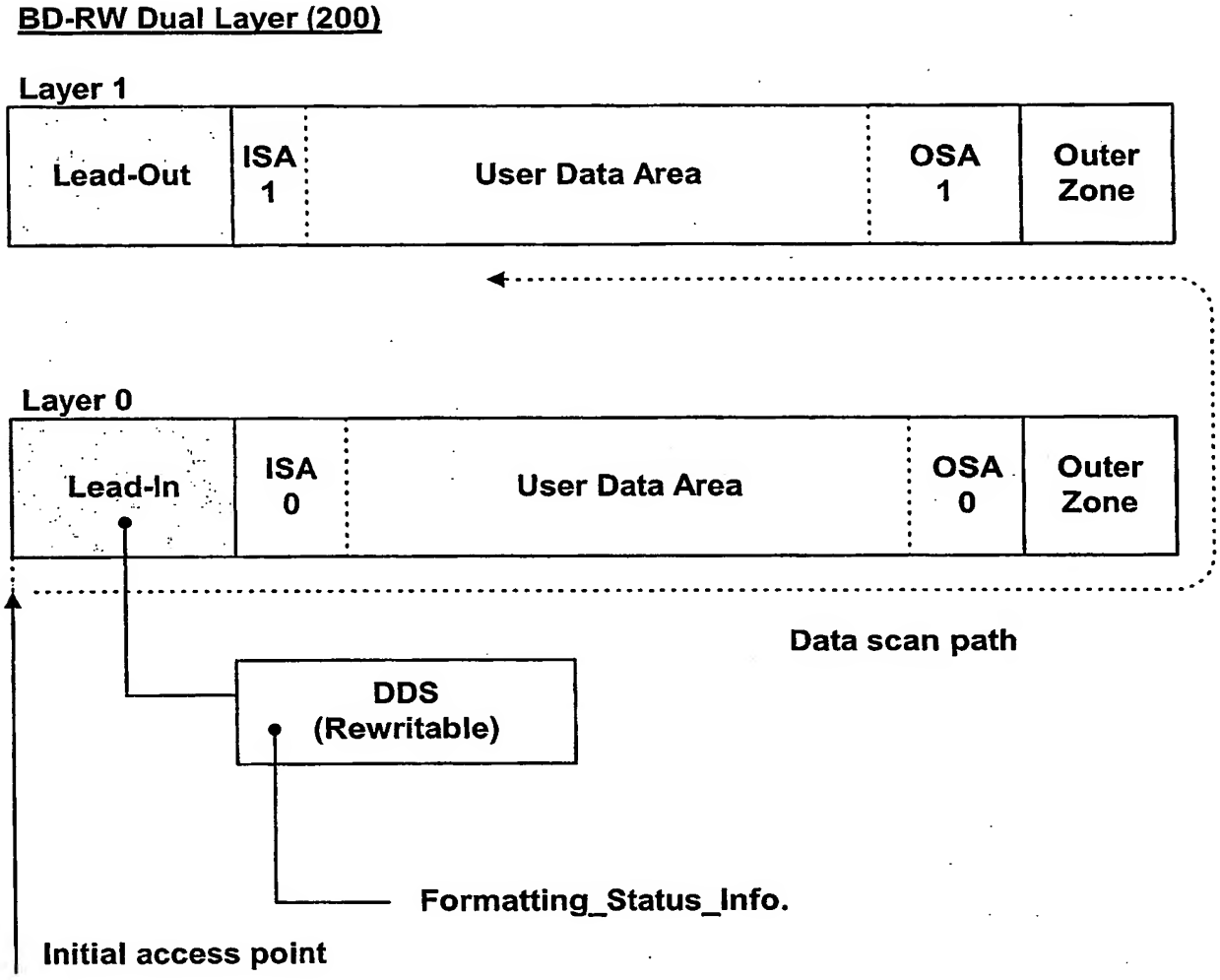

BD-RW Dual Layer (200)
Layer 1
Lead-Out
ISA 1
User Data Area
OSA 1
Outer Zone
Layer 0
Lead-In
ISA 0
User Data Area
OSA 0
Outer Zone
Data scan path
DDS (Rewritable)
Formatting_Status_Info.
Initial access point

FIG. 5

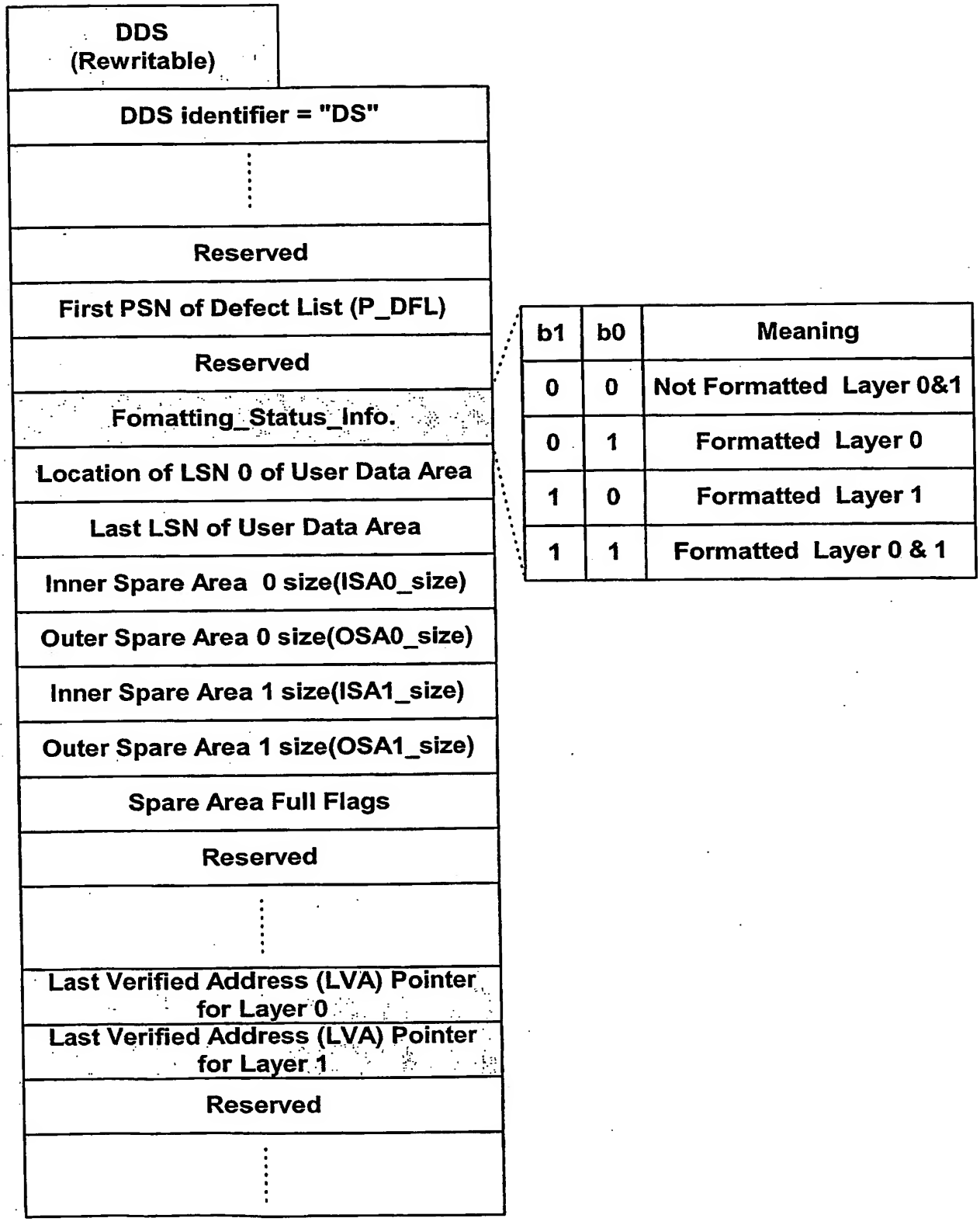

DDS
(Rewritable)
DDS identifier = "DS"
Reserved
First PSN of Defect List (P_DFL)
Reserved
Fomatting_Status_Info.
Location of LSN 0 of User Data Area
Last LSN of User Data Area
Inner Spare Area 0 size(ISA0_size)
Outer Spare Area 0 size(OSA0_size)
Inner Spare Area 1 size(ISA1_size)
Outer Spare Area 1 size(OSA1_size)
Spare Area Full Flags
Reserved
Last Verified Address (LVA) Pointer for Layer 0
Last Verified Address (LVA) Pointer for Layer 1
Reserved
b1 b0 Meaning
0 0 Not Formatted Layer 0&1
0 1 Formatted Layer 0
1 0 Formatted Layer 1
1 1 Formatted Layer 0 & 1

FIG. 6

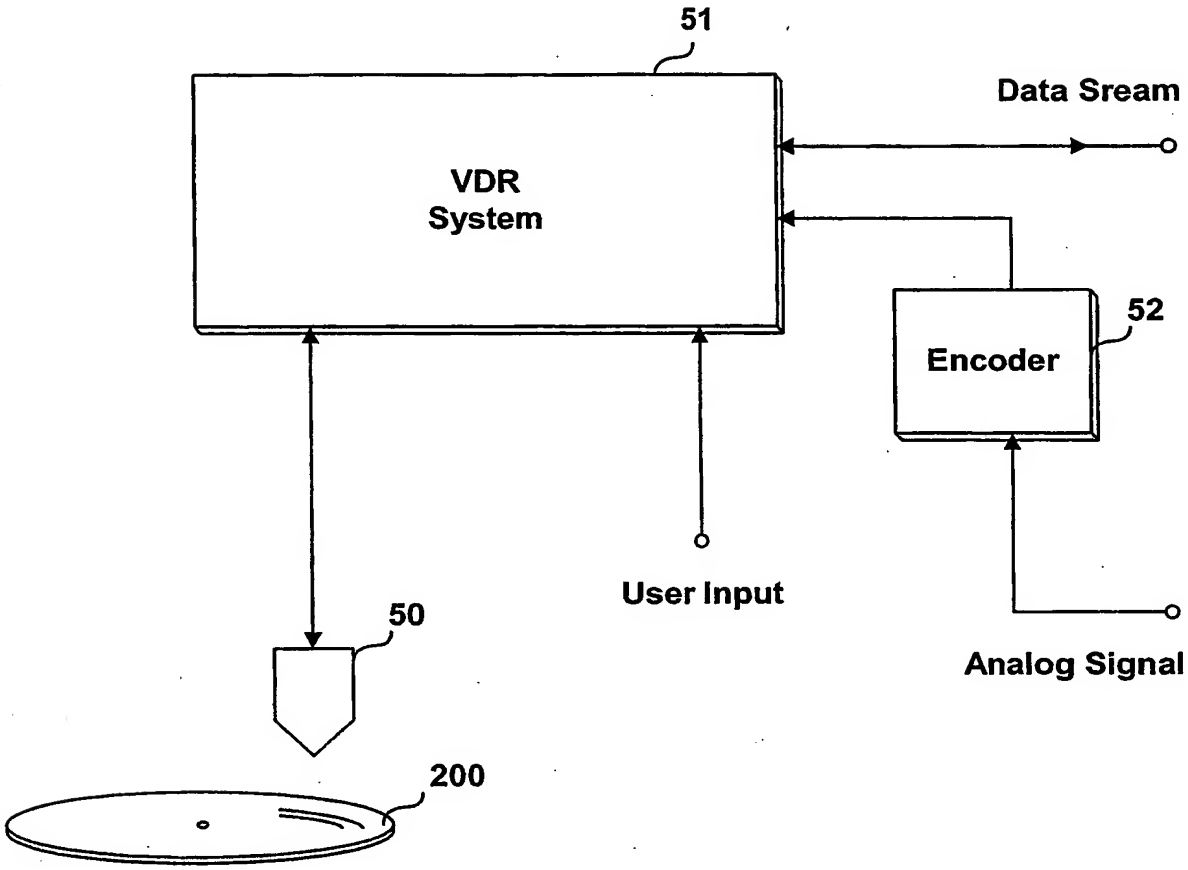

51
Data Sream
VDR
System
52
Encoder
User Input
50
Analog Signal
200

FIG. 7(a)

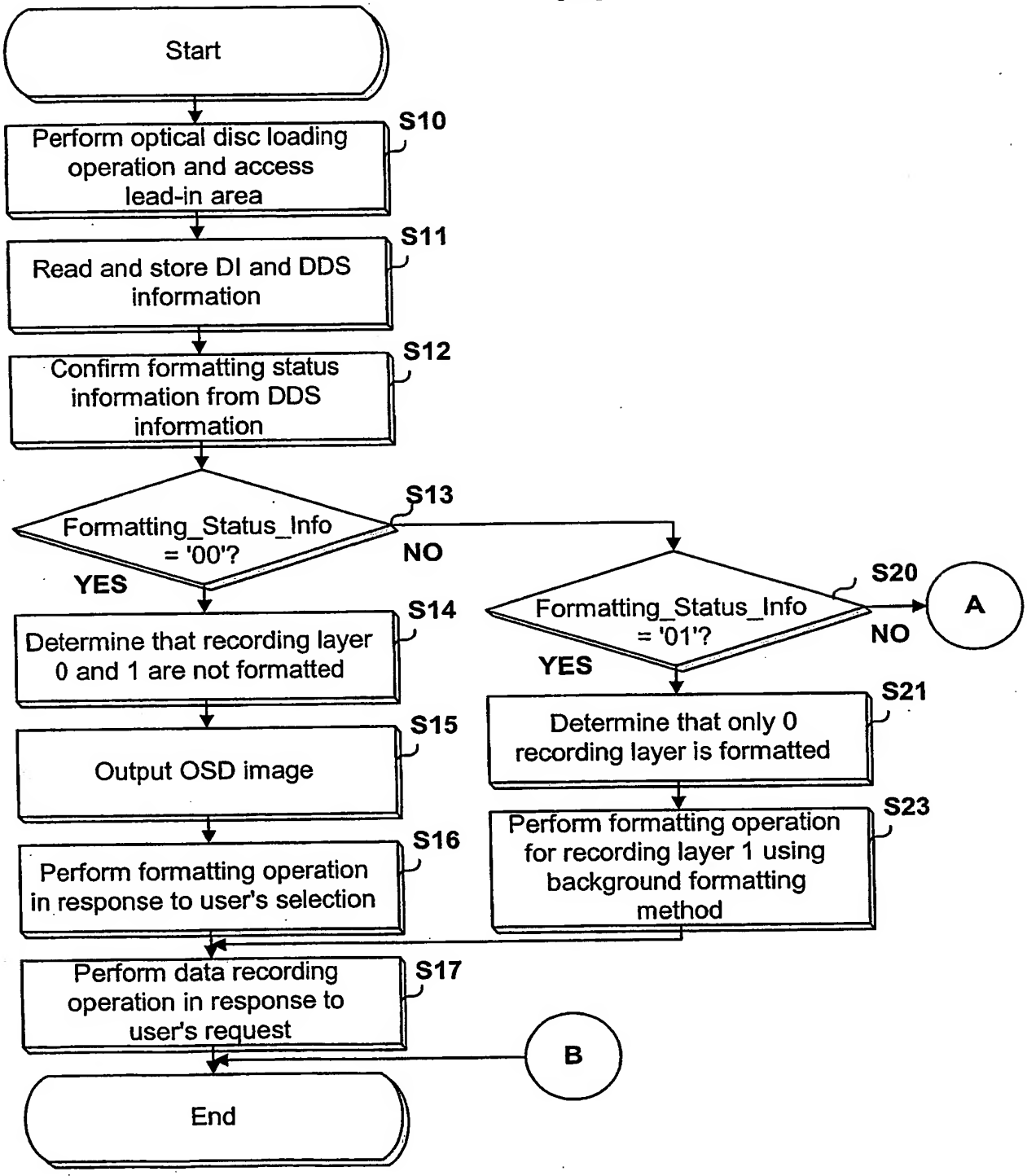

Start
Perform optical disc loading operation and access lead-in area
S10
Read and store DI and DDS information
S11
Confirm formatting status information from DDS information
S12
Formatting_Status_Info = '00'?
S13
YES
NO
Determine that recording layer 0 and 1 are not formatted
S14
Output OSD image
S15
Perform formatting operation in response to user's selection
S16
Formatting_Status_Info = '01'?
S20
A
YES
NO
Determine that only 0 recording layer is formatted
S21
Perform formatting operation for recording layer 1 using background formatting method
S23
Perform data recording operation in response to user's request
S17
B
End

FIG. 7(b)

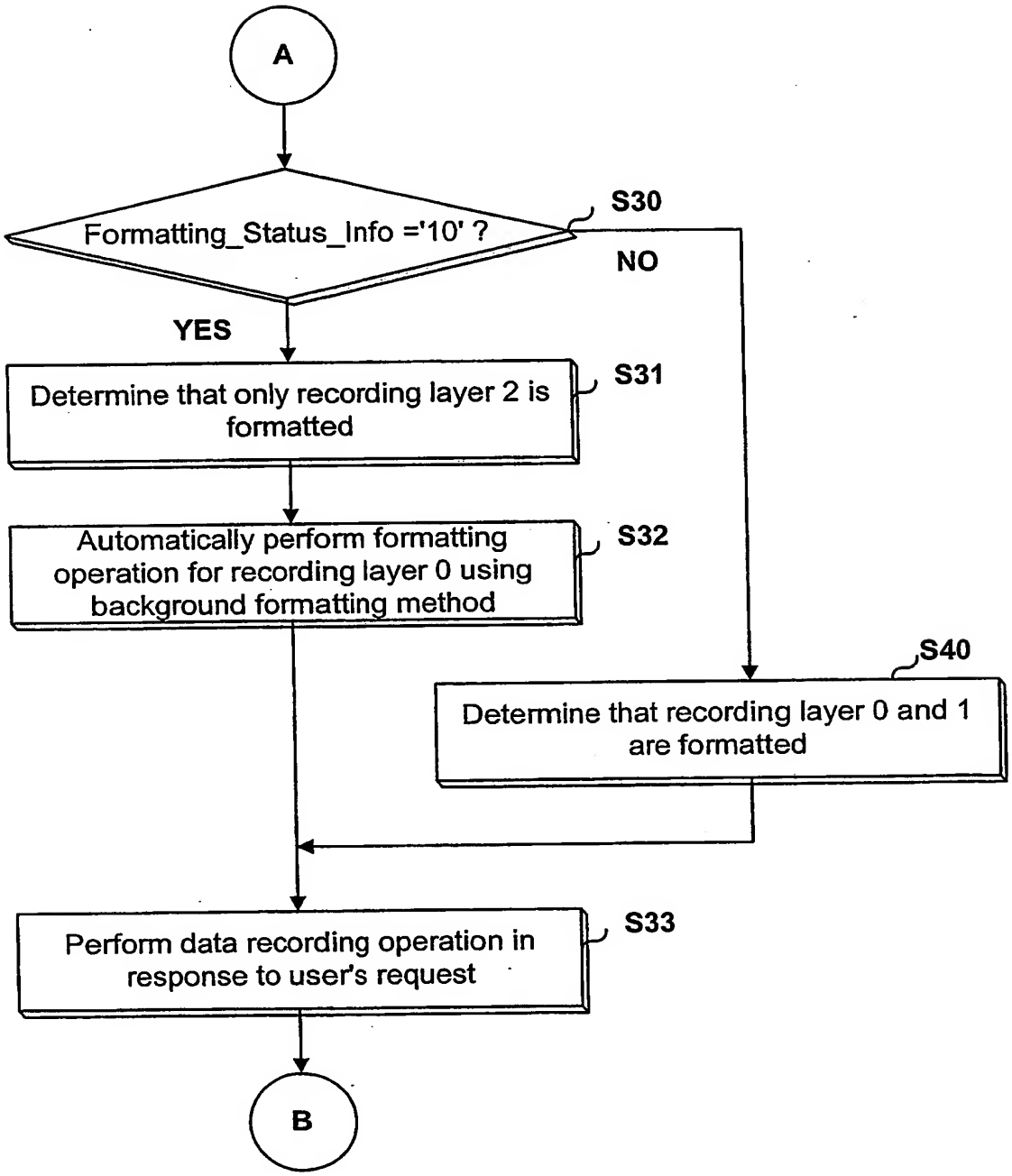
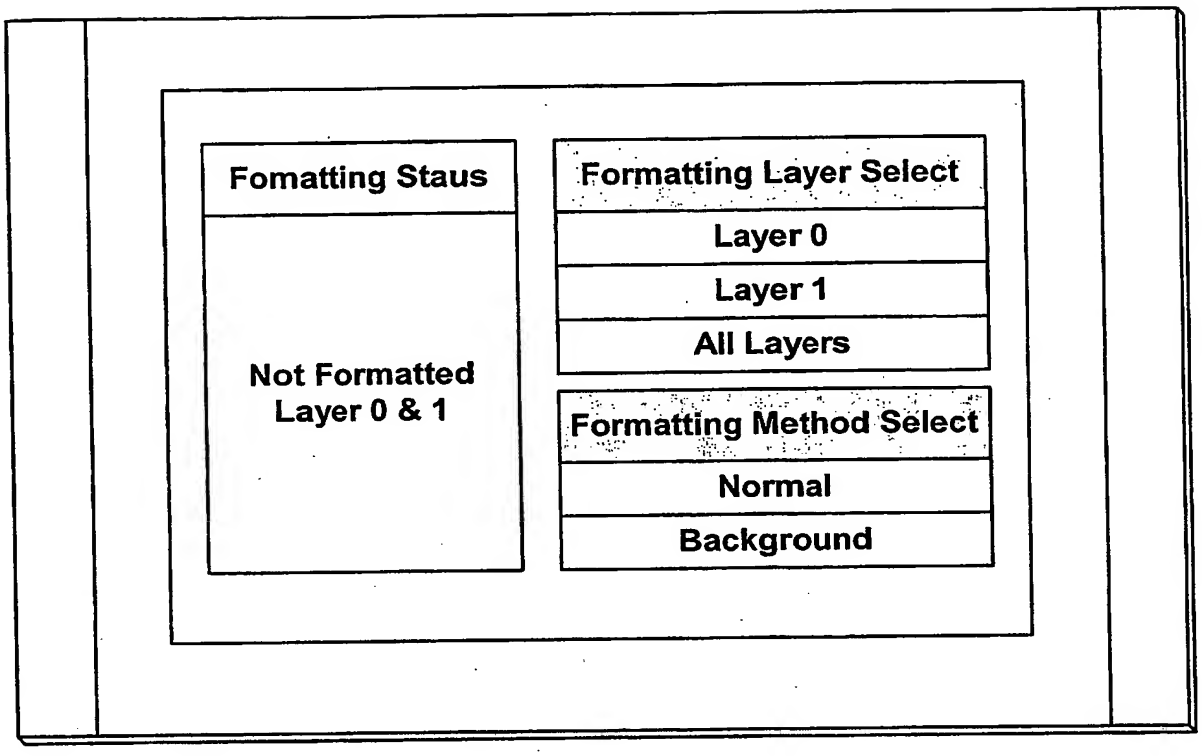

A
Formatting_Status_Info ='10' ?
S30
NO
YES
Determine that only recording layer 2 is formatted
S31
Automatically perform formatting operation for recording layer 0 using background formatting method
S32
S40
Determine that recording layer 0 and 1 are formatted
Perform data recording operation in response to user's request
S33
B

FIG. 8


Fomatting Staus
Not Formatted
Layer 0 & 1
Formatting Layer Select
Layer 0
Layer 1
All Layers
Formatting Method Select
Normal
Background

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR03/01116

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 G11B 7/007

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC7 G11B7/00-7/24, G11B20/00-20/24

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPI,PAJ"MULTI","LAYER","OPTICAL","DISK","FORMAT"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 13-086195 A(SONY CORP.) 30 MARCH 2001 see abstract	1
A	JP 03-290872 A(HITACHI ELECTRON ENG. CO. LTD.)20 DECEMBER 1991 see abstract	1
A	EP 768652 A2(NEC CORP.) 16 APRIL 1997 see abstract	1

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
06 OCTOBER 2003 (06.10.2003)	06 OCTOBER 2003 (06.10.2003)

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